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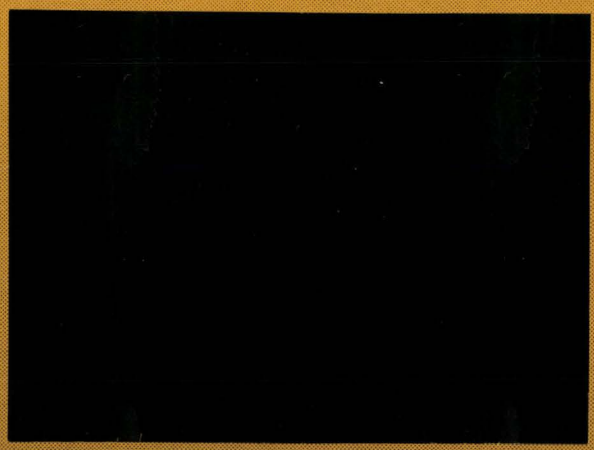
FOREST PEST MANAGEMENT



United States
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Forest Pest Management
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BIOLOGICAL EVALUATION

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Egg Mass Survey for Jack Pine Budworm,
Choristoneura pinus Freeman,
in the Nebraska National Forest

1987

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ABSTRACT

Between 1978 and 1980, jack pine budworm severely defoliated [466 hectares] 1,166 acres of jack pine in the Bessey Division of the Nebraska National Forest. In 1987 budworm severly defoliated about [645 hectares] 258 acres in one jack pine stand. Egg mass densities indicate that 1988 larval populations in five stands will be sufficient to cause moderate to severe defoliation of jack pine.

INTRODUCTION

Jack pine budworm, Choristoneura pinus Freeman, has been recognized as the principal defoliator of jack pine, Pinus banksiana Lamb., in the Lake States region for about 60 years (Foltz 1972). Most reported tree losses have been in suppressed and intermediate size tree classes (Allen et al. 1968). Severe infestations may substantially reduce tree growth (Benjamin et al. 1961).

Choristoneura pinus was first detected in the Bessey Division of the Nebraska National Forest during a 1978 survey for jack pine decline (James 1979). By 1979 defoliation was widespread. An egg mass survey of the jack pine plantings in July 1979 indicated that a large budworm population and severe defoliation could be expected in 1980. In 1980 a pilot control project was conducted in four plantings. Two plantings were treated with Bacillus thuringiensis and two plantings were used as checks. Larval populations and defoliation in the two treated plantings and in one of the untreated plantings decreased to near zero. Numbers of budworms and defoliation in one untreated planting remained high. Causes of the post treatment decrease in larvae in the one untreated planting are unknown. In 1981 only one budworm larva was obtained during a follow-up survey of the four plantings (Hostetler 1981).

In 1987, personnel of the Nebraska National Forest detected pockets of defoliation in the jack pines. This report contains the results of a survey for jack pine budworm egg masses in the jack pine plantings in the Bessey Division of the Nebraska National Forest and outlines management recommendations.

TECHNICAL INFORMATION

Insect: Jack pine budworm — *Choristoneura pinus pinus* Freeman (Lepidoptera: Tortricidae)

Hosts: Jack pine — *Pinus banksiana* Lamb.
Red pine — *Pinus resinosa* Ait.

Life History: The jack pine budworm completes one generation each year.

Stage	Time	Location in Host
Eggs	mid to late July	Laid on foliage usually in two or three rows on the flat side of a pine needle.
Small larvae	August to April (Overwinter)	In hibernaculum (silken cocoons) under bark scales on branches and trunk.
Large larvae	May to early June	Initially in flower clusters, later migrate to new foliage.
Pupae	late June	Among webbed-together needles or in between webbed shoots.
Adult moths	early July	In flight.

Evidence of Infestation

(1) Presence of partially eaten foliage.
(2) Current-year needles webbed together by larvae.
(3) Mature larvae feeding on needles.
(4) Egg masses on new growth.
(5) Damage first appears in the tops of trees and moves downward.
(6) Continued severe defoliation causes top mortality and then total tree mortality.

HISTORICAL BACKGROUND

In the spring of 1901 a survey party organized by the Division of Forestry, U.S. Department of Agriculture made a reconnaissance of the Nebraska sandhill region for timber growing purposes. As a result, members of the party recommended forest reserves within what is now the Nebraska National forest. President Theodore Roosevelt issued a proclamation on April 16, 1902, establishing the Dismal River Forest Reserve located in Thomas and Blaine Counties (Bessey Division), and the Niobrara Forest Reserve in Cherry County (McKelvie Division). The total area reserved encompassed about 206,000 acres. Within these reserves, approximately 31,000 acres were successfully planted to various coniferous species resulting in one of the largest man-made forests in the world (U.S. Forest Service 1974).

Tree planting was initiated in 1903 with the planting of 70,000 jack pine. During the ensuing 38 years, more than 8,000 acres of sandhills grassland on the Bessey Division were planted with jack pine. This resulted in the successful establishment of 4,600 acres of jack pine plantations (Boldt 1969, Droze 1977). Most of the jack pine planting stock came from Minnesota (Boldt 1969). In some of the plantings involved, 2-1 jack pine stock was planted at 3 feet intervals along furrows spaces about 6 feet apart for a density of about 2,200 per acre.

Some jack pine stands displayed effects from competition within the first decade after planting. Consequently, in 1920, a thinning trial was conducted on a single 0.25 acre plot. Early favorable responses by trees to the thinning led to installation of a more elaborate thinning trial in 1923 (Boldt 1969). In non-thinned stands, "natural mortality" resulted in a reduction in stocking similar to that achieved in thinned stands. The cause of mortality appeared to be closely correlated with a two-year drought in which precipitation was less than 75 percent of normal (Boldt 1969), rather than caused by stand stagnation reported as characteristic of jack pine plantations (Fowells 1965). Thirty-six years of natural mortality in unthinned stands removed nearly as large a proportion of trees as did heavy thinning.

Most of the jack pine plantations remained intact until May 1965, when many were destroyed by fire. The fire, started in grassland by lightening west of the Bessey Division, spread rapidly and consumed [4,420 hectares] 10,970 acres of trees of many species (U.S. Forest Service 1965). Only about 20 percent of the burned area has been planted or naturally regenerated.

Shortly before the fire, root disease, caused by Fomes annosus (Fr.) Cke., was found in two areas of thinned jack pine (Stewart 1965). Trees on these areas were subsequently destroyed by fire; no further evidence of the root disease has been found in the burn area. Since 1980, Fomes annosus has been found in five other small root disease centers in the Bessey Division.

In 1978 the etiology, extent, and distribution of jack pine decline in plantings within the Nebraska National Forest was determined with ground transect and variable plot surveys (James 1979). Approximately 16 percent of the sampled trees were dead or declining. The major fungal associate with this decline was Ceratocystis minor. Secondary insects, particularly Ips calligraphus (Gemar) and Dendroctonus valens LeConte, were associated with the decline. Local site conditions probably predisposed trees to attack by associated insects and fungi (James 1979). Resurveys of eight semi-permanent plots in 1980, 1982, and 1983 indicated that mortality had decreased significantly in these plots (Sharon 1984). By 1984 jack pine decline had "disappeared" in the monitored areas.

After the 1965 fire, an outbreak of pine engraver (Ips spp.) occurred in residual jack pine stands. Ips populations increased in fire-killed timber and spread to nearby live trees. Because of potential damage to residual stands, 50,644 jack pine on 12,249 acres were felled and treated with 1.5 percent lindane during June 1967 (Chansler 1968). The project was apparently successful in reducing insect populations to endemic levels.

HOST STAND CONDITION

Between 1903 and 1941, [1840 hectares] 4,600 acres of jack pine were planted in the sandhills of the Bessey District of the Nebraska National Forest in Thomas County, Nebraska. In 1987 the 1166 acres remaining were divided into 421 acres of sawtimber, 444 acres of poles and 301 acres of nonstock. The 5 + inch DBH timber produces an estimated 38 cubic feet/acre/year of sawtimber, 49.1 cubic feet/acre/year of pole timber and, 13.4 cubic feet/acre/year of nonstock timber. Many of the pole and sawtimber size jack pines are near or beyond the rotation age of 60-85 years recommended by Barrett or the 70-90 year rotation age recommended in the Forest Service's standards and guidelines. Natural regeneration of the jack pine is minimal.

EVALUATION METHODS

Jack pine plantings in the Bessey Division of the Nebraska National Forest were aerial surveyed in July, 1987 and areas of heavy defoliation were recorded on a topographic map. Extent and year of defoliation in stand 1 was determined by ground surveys.

An egg mass survey was conducted July 21-31, 1987 in five jack pine stands or plantings (Figure 1). In stand 1, a transect was run through the center of the planting. Sample plots were established every 20 chains. End plots were 20 chains from the stand edge. Five, 24 inch long foliated branches were collected within each plot; one in a jack pine nearest the center of the plot and one each in pines 2 chains to the north, south, east, and west of the plot center. Only one plot was sampled in stands 2, 3, 4, and 5. Five branches were collected from each of these plots in the manner described for stand 1. Foliage samples were bagged, labeled, and transported to the laboratory. The number of egg masses on each branch were counted and examined for parasitism with a microscope. Each branch was rated for amount of current budworm defoliation with the following rating scheme:

Rating	Percent Defoliation
0	0
1	1-25
2	26-50
3	51-75
4	76-99
5	100

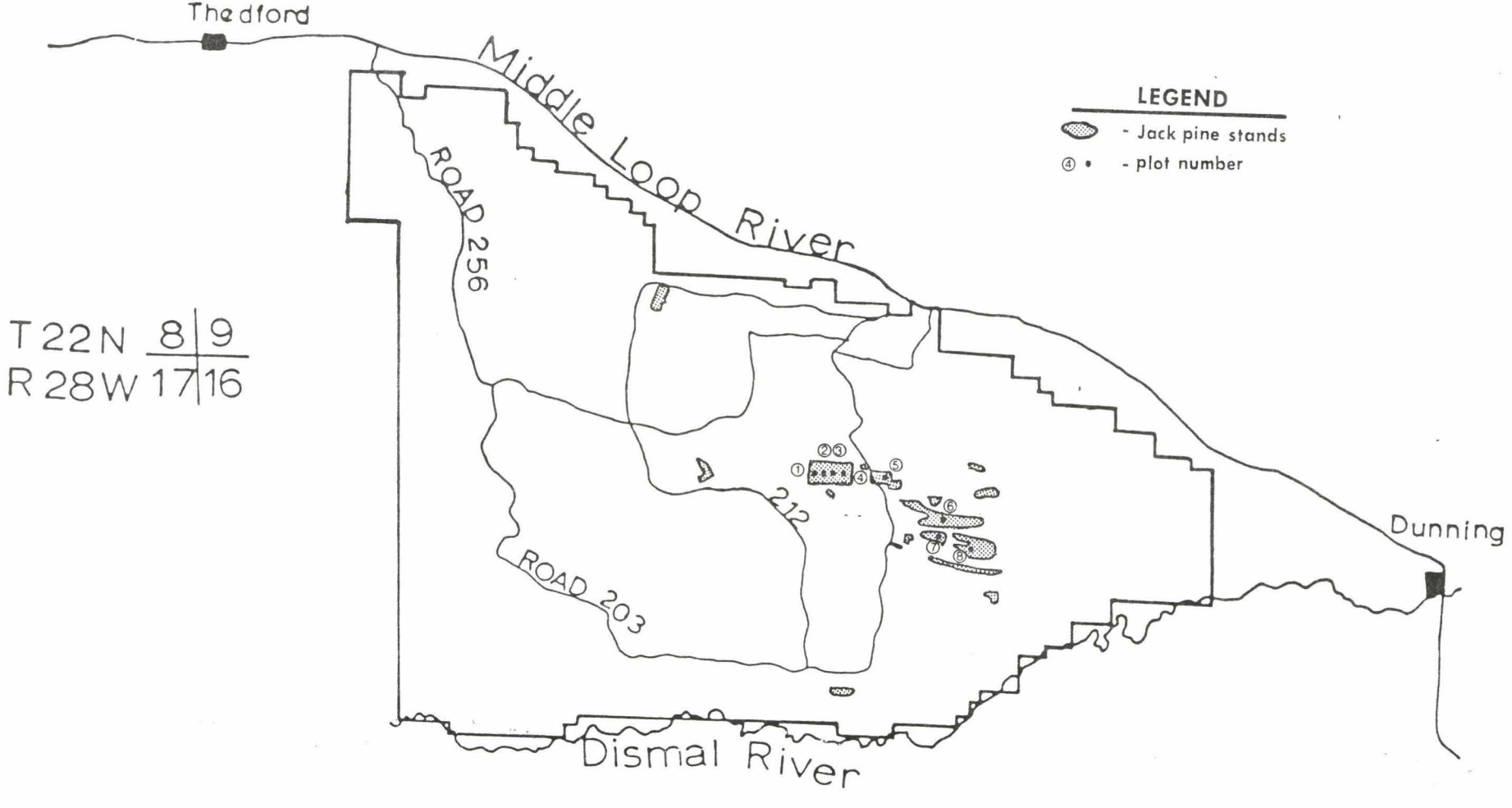

FIGURE 1 -- Location of jack pine stands and sample plots, Bessey Ranger District, Nebraska National Forest, 1987.

RESULTS

Significant defoliation was visible from the air in stand one; defoliation was not observed in stand 2, 3, 4, and 5. Most of the defoliation occurred during 1987 and scattered pockets of trees were defoliated in 1986. A few isolated trees were defoliated in 1985.

Branch samples from stand 1 were defoliated between 26 and 75 percent (Tables 1, 2). Defoliation was not apparent on branches from stands 2, 3, 4, and 5.

Egg masses were found in every stand (Tables 1, 3, 4). New/old egg mass ratios from stand 1 and the presence of new egg masses in the other stands indicate that the egg mass density is increasing in all of the surveyed stands (Tables 3, 4, 5).

Very few eggs were parasitized.

DISCUSSION

Defoliation in 1988 will likely range from moderate to very severe throughout the Jack pine type because egg mass densities increased in all stands and parasitism of these egg masses was very low.

A 1978 outbreak in the same stands collapsed after 3 years. Application of Bacillus thuringiensis to severely infested stands and an increase in parasitism probably contributed to the collapse of the 1978 outbreak. Parasites and other natural controls may cause the collapse of the current outbreak, probably in 1989. Many of the jack pine are in a stagnated and weakened condition and will die if they are severely defoliated for two to three years.

The Forest Service Plan for the Bessey Division of the Nebraska National Forest calls for the maintenance of 4,000 acres of jack pine for quail habitat and heron reproduction. The 1,166 acres in the Forest have matured and no longer provide the undergrowth required by quail. A younger stand with undergrowth is needed. A heron rookery located in the northwest corner of stand 1, 10 chains from both the west and north boundaries, needs to be protected. The timber value of the jack pine is minimal. Very little regeneration has been observed in the stands.

ALTERNATIVE ACTIONS

Alternative 1: No action. Defoliation and subsequent damage to the jack pines are assumed acceptable. However, mortality within the jack pine stands will be high. An outbreak of bark beetles (Ips spp.) may occur in the weakened pines.

Alternative 2: Suppression with Chemical Insecticides. Effective aerial application of chemical insecticides will reduce budworm populations to low levels and provide substantial foliage protection in 1988. Chemical insecticides currently registered with the Environmental Protection Agency (EPA) include carbaryl (Sevin®) and mexacarbate (Zectran®). Acephate (Orthene®) and trichlorfon (Dylox®), are not specifically registered for jack pine budworm but may be available for use under the current labels. Population reduction and consequent foliage protection should last until about 1994.

AVDANTAGES: Chemical insecticides normally provide efficacy of 95 percent or more of the current insect population. Since chemical insecticides have a relatively long residual effect on the foliage, they can be applied at an early date, and thus, provide substantial amounts of foliage protection. When applied according to the label directions, chemical insecticides will have no significant impact on vertebrate populations.

DISADVANTAGES: Chemical insecticides are broad spectrum and, therefore, can significantly affect non-target invertebrates. The effects of chemical suppression are generally short-lived (5 to 10 years) making multiple applications necessary over the stand rotation. Since the jack pine stands area currently at or beyond the expected biological rotation age, significant tree mortality will negate current benefits of budworm population reduction and foliage protection.

Alternative 3: Suppression with microbial insecticides. Currently, Bacillus thuringiensis var. kurstaki (Thuricide®, Dipel®, Futura®) is registered for jack pine budworm. Advantages and disadvantages of a microbial insecticide are the same as for chemical insecticides except:

1. Efficacy is generally around 85 to 95 percent
2. Reduced level of foliage protection
3. Narrow application window
4. Less impact on invertebrates - impact confined to actively feeding lepidoptera
5. Less residual activity of the insecticide on the foliage.

Alternative 4: Regeneration harvesting. Average age of the mature jack pine stands (with available Stage II data) is 63 years. Of these, 52 percent are age 51 to 60; 30 percent are age 61 to 70; and, 18 percent are age 71 to 80. To retain the jack pine cover type on the currently stocked acres, regeneration harvesting of all jack pine should be completed within the next 30 years.

With regeneration harvesting of the current jack pine cover type, an additional 834 to 1,834 acres needs to be planted in jack pine to meet the Forest Plan direction of retaining 2,000 to 3,000 acres of jack pine cover. For each acre not naturally regenerated, an additional acre needs to be planted. To meet the requirement of age diversity a minimum of 250 to 330 acres need to be regenerated per decade over the next 60 to 80 years.

Alternative 5: Type conversion. In this alternative the jack pine is underplanted with one or more species of shade tolerant trees. This would break the forest into smaller stands. The crane rookery would be temporarily preserved and habitat for quail and other wildlife would be increased. The jack pine would be allowed to be replaced by the under plantings. For each acre of jack pine cover converted, an additional acre should be planted to jack pine.

Alternative 6: Plant natural openings. Natural openings in the current jack pine stands could be planted to one or more species of light tolerant tree species other than jack pine. This would provide the same advantages and disadvantages as in Alternative 5.

RECOMMENDATIONS

The general recommendation for stands 2, 3, 4, and 5 is a combination of alternative 3, spraying with microbial insecticides, and alternative 5, underplanting the jack pine. Spraying the plantations would maintain the jack pine canopy needed for survival of the shade-tolerant understory. As the understory matured, the jack pine would be allowed to die. This would create additional wildlife habitat. Bacillus thuringiensis is environmentally safe and does not affect nontarget organisms. Species diversity of stands also could be increased by planting open areas (alternative 6) with non-host tree species.

The general recommendation for stand 1 is a combination of underplanting (alternative 5) and planting natural openings (alternative 6). These alternatives would increase the species diversity and quail habitat of the stand and temporarily preserve the heron rookery. The rookery will be destoyed when the trees die. Aerial application of insecticides and logging are not recommended because they might disturb the nesting herons.

Table 1. Jack pine budworm defoliation and egg masses in five jack pine stands on the Nebraska National Forest in 1987.

Stand	Plot	Defoliation Rating1/,2/	New Egg1/ Masses per m^2 of foliage	Old Egg1/ Masses per m^2 of foliage	New/Old1/ Egg Masses per m^2 of foliage
1	1	2.96	13.7	5.3	2.6
1	2	3.72	14.7	7.4	2.0
1	3	2.80	13.9	2.0	7.0
1	4	3.56	12.7	3.3	3.8
2	1	0.13	1.0	0.0	NA
3	1	0.02	1.6	0.0	NA
4	1	0.02	0.9	0.0	NA
5	1	0.04	0.9	0.0	NA

1/ n=5 jack pine branches/plot
2/ key: 0 = 0% defoliation, 1 = 1-25% defoliation, 2 = 26-50% defoliation, 3 = 51-75% defoliation, 4 = 76-99% defoliation, 5 = 100% defoliation.

Table 2. Defoliation of five jack pine stands by jack pine budworm on the Nebraska National Forest in 1987.

		Defoliation in Rating in Subplots:1/						
Stand	Plot	Central	North	South	East	West	Mean	SD
1	1	2.76	3.42	3.43	2.06	3.15	2.96	0.57
1	2	3.39	4.17	3.73	3.76	3.54	3.72	0.03
1	3	2.33	2.70	3.17	2.45	3.37	2.80	0.45
1	4	3.35	3.59	3.61	3.39	2.84	3.56	0.02
2	1	0.04	0.30	0.07	0.15	0.07	0.13	0.01
3	1	0.02	0.01	0.00	0.06	0.00	0.02	0.00
4	1	0.02	0.00	0.08	0.00	0.00	0.02	0.03
5	1	0.02	0.02	0.04	0.07	0.05	0.04	0.00

1/ key: 0 = 0% defoliation, 1 = 1-25% defoliation, 2 = 26-50% defoliation, 3 = 51-75% defoliation, 4 = 76-99% defoliation, 5 = 100% defoliation.

Table 3. New egg masses on branches in five jack pine stands in the Nebraska National Forest in 1987.

Stand	Plot	New egg masses per m^2 of foliage in subplots: Central	North	South	East	West	Mean	SD
1	1	3.86	7.96	10.87	16.40	29.42	13.70	9.90
1	2	15.16	9.45	6.18	17.21	25.24	14.65	7.38
1	3	22.42	22.50	8.77	2.88	13.20	13.95	8.58
1	4	24.53	4.57	13.40	12.65	9.27	12.68	7.52
2	1	1.79	0.00	2.53	0.00	0.90	1.04	1.11
3	1	2.99	0.00	1.20	3.64	0.00	1.57	1.69
4	1	0.00	0.00	1.44	0.00	2.87	0.86	1.28
5	1	0.00	1.66	2.69	0.00	0.00	0.87	1.25

Table 4. Old egg masses of jack pine budworm on branches in five jack pine stands on the Nebraska National Forest in 1987.

Stand	Plot	Old egg masses per m^2 of foliage in subplots: Central	North	South	East	West	Mean	SD
1	1	2.95	8.73	2.74	3.19	8.81	5.28	3.19
1	2	16.57	6.65	5.48	2.82	5.22	7.35	5.34
1	3	3.91	2.39	0.00	0.00	3.80	2.02	1.94
1	4	3.59	0.00	6.97	6.04	0.00	3.32	3.27
2	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5. Jack pine budworm egg masses in five jack pine stands on the Nebraska National Forest, July 1987.

Stand	Plot	Mean egg masses per m^2 of foliage: 1/ New	Old	New:Old
1	1	13.7	5.3	2.6
1	2	14.7	7.4	2.0
1	3	13.9	2.0	7.0
1	4	12.7	3.3	3.8
2	1	1.0	0.0	NA
3	1	1.6	0.0	NA
4	1	0.9	0.0	NA
5	1	0.9	0.0	NA

1/ n = 5 jack pine branches per plot

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